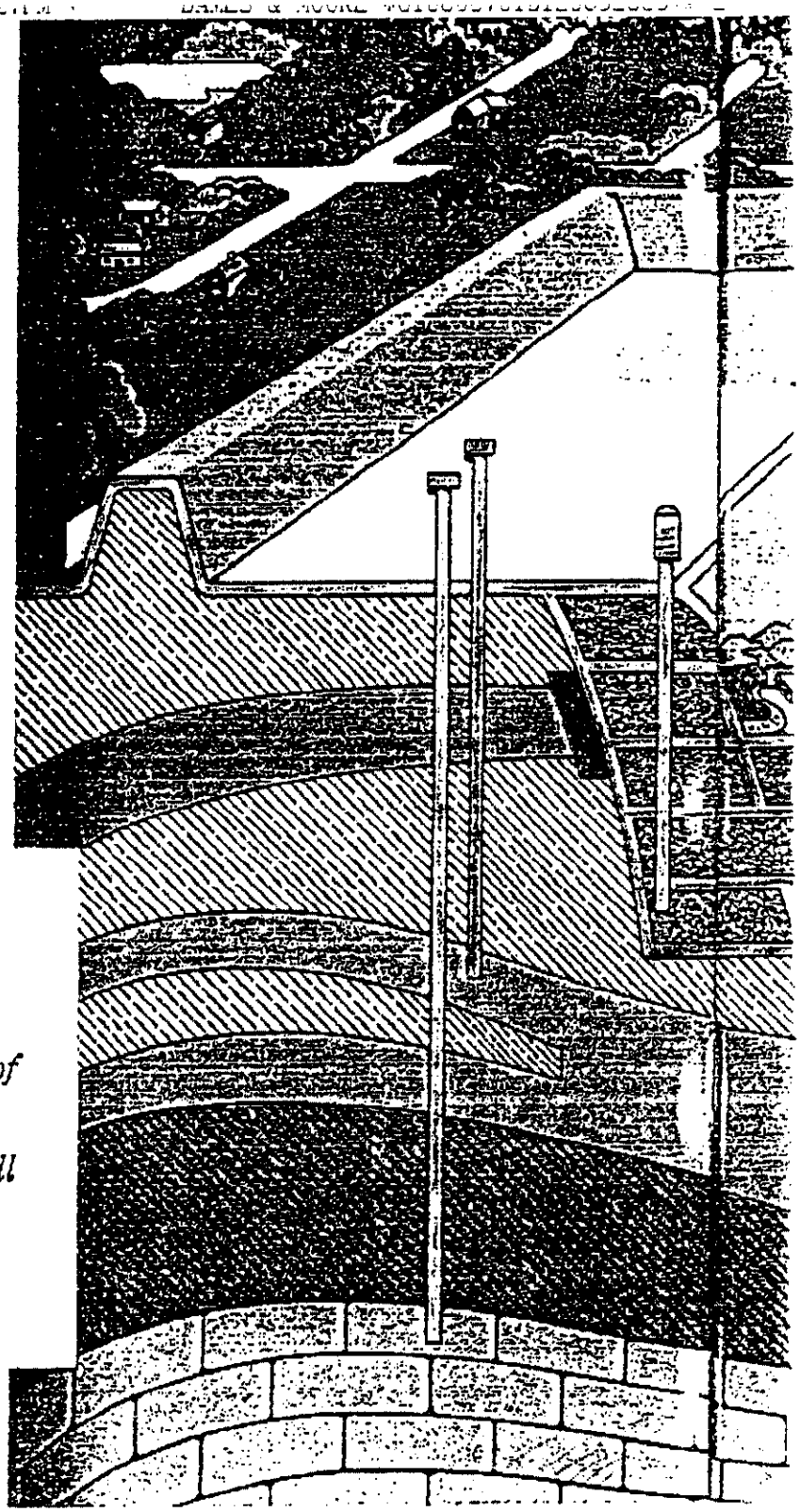
Subtitle D: How Will it Affect Landfills?



THE PUBLICATION OF SUBTITLE D REGULATIONS in August 1988 will affect landfill costs across the U.S. How deeply costs are affected will depend on how states revise their regulations and implement the basic Subtitle D concepts. This article reviews landfill costs of 1975 with those of today, and projects likely costs for a 1990 Subtitle D sample site.

This expert projects the cost of operating a Subtitle D landfill in the 1990s.

Even without Subtitle D, landfill costs were rising dramatically. One reason is that absolutely everything involved in landfill design is more complicated and requires more money than anticipated. For example, simply finding and studying a site the public will accept technically, environmentally, and politically takes substantial time and money. Increased public awareness, and demands for compensation and more environmental control also have increased costs. Time delays in siting require that more money be spent. And now, state and local governments require special assessment fees for recycling, environmental repair of old sites, groundwater protection, etc., which are normally collected by the landfill.

Strict regulations, like Subtitle D, increase requirements for environmental controls and long-term care, and place more comprehensive, and thus costly, requirements on landfill operators.

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State of the Art Landfill under Subtitle D

Subtitle D established national criteria for municipal solid waste landfills (MSWLF's). Different requirements are outlined for other non-hazardous wastes, but the discussion in this article will be limited to general new or

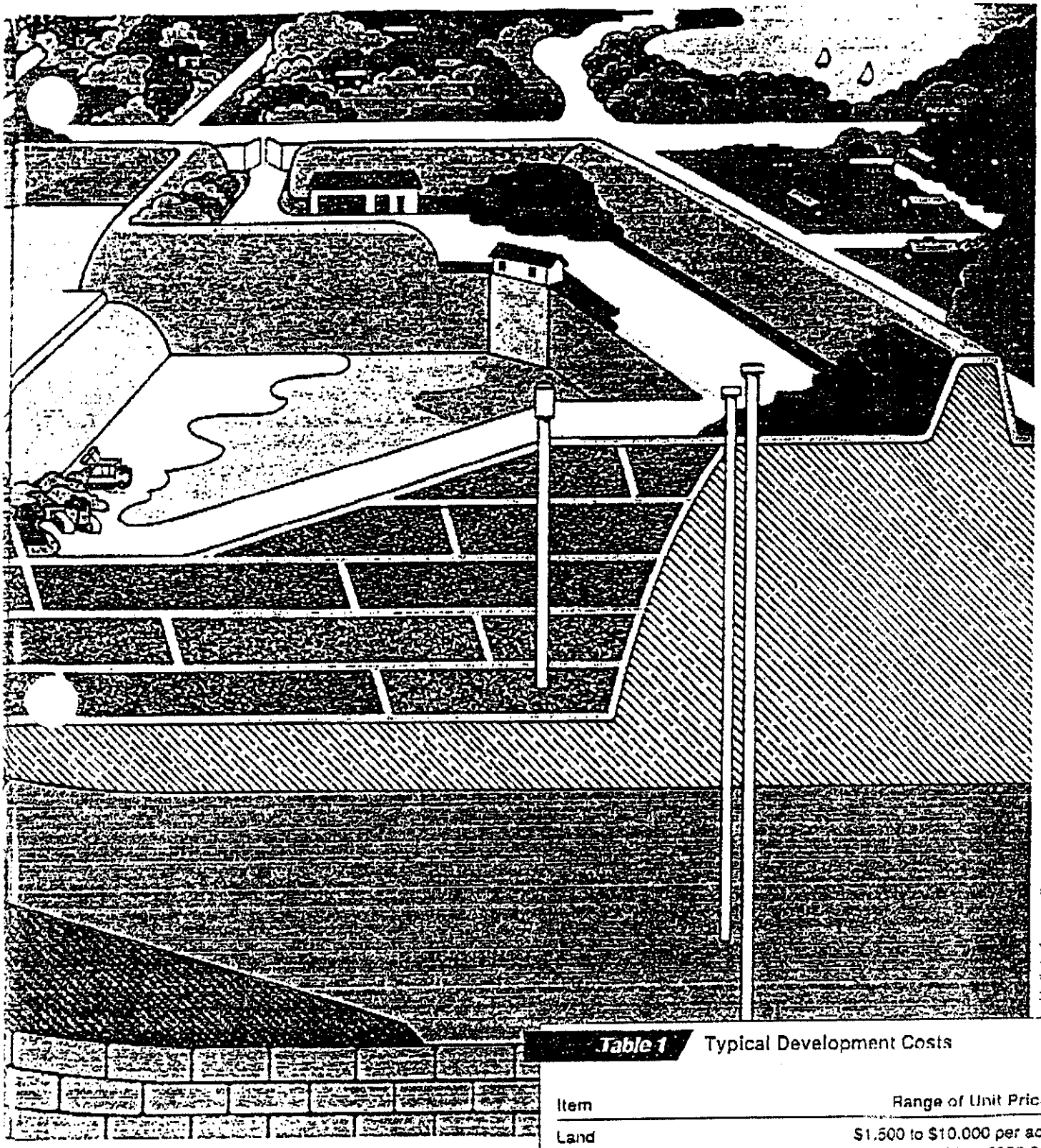

Table 1 Typical Development Costs

Item	Range of Unit Prices
Land	$1,500 to $10,000 per acre
Engineering	$100,000 to $800,000
Legal fees	$5,000 to $100,000
Licensing and permit review fees	$5,000 to $50,000

expanded municipal solid waste landfills.

Subtitle D is more restrictive now than ever before on locations that cannot be used for MSWLFs, making it more difficult, and costly, to find suitable sites. Specifically, Subtitle D's basic design, closure, and long-term care requirements demand more and better environmental controls, which will increase real costs for new or expanded landfills.

A Subtitle D state of the art landfill will likely have: one or two liners; leachate collection systems; final cover systems; more inspections and record keeping; more control of vectors; methane gas control; more detailed surface water run-on and run-off controls; more restrictions on wastes that can be received; a detailed

Table 2 Typical Landfill Development Costs

m	Range of Unit Prices
e A s Construction	
;ravel access road	$12.00-$16.00 per linear foot
;ituminous access road	$22.00-$24.00 per linear foot
rthwork Construction	
:learing & grubbing	$1,500-$3,000 per acre
'opsoil excavation & placement	
topsoil excavating & stockpiling	$1.05-$1.40 per cubic yard
topsoil excavating & placement	$1.80-$2.50 per cubic yard
se area preparation	
;ubsoil excavating & stockpiling	$1.10-$2.00 per cubic yard
;ubsoil excavating & placement	$1.35-$3.00 per cubic yard
)n-site clay haul & placement	$2.40-$4.00 per cubic yard
;and blanket placement	$8.80-$12.00 per cubic yard
'lexible membrane liner	$7.20-$10.00 per square yard
;eed, fertilizer, & mulch	$1,000-$1,500 per acre
achate Collection/Transfer System	
:ollection system piping	$17.50-$22.00 per linear foot
:leanouts	$1,400-$1,500 each
ainage System Control Devices	
lat-bottom ditch construction	$1.00-$2.50 per linear foot
Inderdrain system	
drainage pipe	$17.50-$25.00 per linear foot
select granular fill	$8.80-$12.00 per cubic yard
;as migration control	$5,000-$10,000 lump sum
dministration, construction, & other miscellaneous costs	$150,000-$300,000 lump sum
scel' ous	
ac n and gate	$2,000-$3,000 lump sum
:cale ...use equipment shed	$66,000-$80,000 lump sum
'acility fencing	$10,[redacted]-$15,[redacted] per linear foot
'ruck scale	$36,000-$40,000 each
)ther miscellaneous site upgrading	$10,000-$15,000 lump sum
s Venting System Installation	
llower assembly	$93,000-$150,000 lump sum
;as extraction wells	$7,300-$10,000 each

closure plan and funding to cover closure; financial assurance required upfront or as part of operations, thus increasing gate fees; and groundwater monitoring and corrective actions which may include monitoring systems, sampling and analysis programs, contingency plans with trigger levels, and contingency action plans.

Sounds tough? These requirements are common for new sites and may also be applied retroactively to upgrade existing sites.

Complying with the new requirements will be expensive. The increase in landfill development costs can be a burden in the short-term (up-front liner and leachate system installation), as well as in the long-term (moni-to' throughout the landfill's operating life and th er).

Good financial planning is now a necessity in the landfill business. To account for the increases in design and operations, gate fees at landfills must be increased. Landfill costs can be expected to rise in the areas of pre-development, construction, operations, closure, post-closure, and unanticipated costs.

Pre-development costs

Pre-development costs include site selection, investigation, and permitting costs. Table 1 presents typical predevelopment costs.

These costs will vary widely, depending on the market value of land, the complexity of the state regulations, and the level of service or assistance needed from outside engineers or permitting agencies.

Land costs relate directly to local economics, pre-development land use, and the land's proximity to urban areas. Historically, as public objections to landfills rose, landfills tended to be sited further from city limits; in many instances, this resulted in lower land prices. However, as fuel prices rose, transportation costs increased, and the price of land took on less importance. The desire to be closer to waste generation sources and leachate disposal systems has influenced developers to deal with local objections and to site facilities closer to urban service areas. This typically results in higher land prices. Subtitle D will make the task of finding suitable sites more difficult.

Increased regulatory activity has also influenced landfill design requirements. The process of obtaining permits is changing. In the past, most state regulatory agencies required a single technical submission. Today, the permitting process in many states requires multiple submissions; the process can take two to five years. These multiple submissions and the lengthy licensing time frame have increased engineering costs and legal fees.

Typical costs associated with land prices, engineering and legal costs, permitting fees, and ancillary development costs, will vary widely. Generally, pre-development costs represent less than 10% of total site development costs for a state of the art non-hazardous landfill.

Construction costs

Costs associated with site construction directly relate to the complexity of site design. There are many factors affecting the costs of site construction.

Most important is the type of liner design used (clay liner, synthetic liner, no liner, etc.). The cost of developing a new clay-lined landfill includes the following items: general excavation; liner construction; leachate collection and extraction system design; surface water drain-

age controls; and other facilities such as scale and maintenance buildings, access roads, and fencing.

Table 2 presents typical construction unit prices for sites constructed in 1988. The unit price information presented is for sites constructed in the upper-Midwest.

Typically, the most expensive items in site construction are the liner and leachate collection system. For example, placing a five-foot clay liner with six-inch leachate collection pipes and a one-foot sand blanket in an already excavated, prepared hole, assuming clay was already on-site, would run $40,000 to $50,000 per acre, not including leachate storage tanks, external piping, and manholes.

If clay needs to be hauled on-site, the cost could easily double or triple to $80,000 or even $130,000 per acre because of transportation costs.

Similarly, the cost of a single synthetic liner including six-inch leachate collection pipes and a one-foot sand blanket could range from $60,000 to $100,000 per acre, including extra sub-grade preparation and sand bedding for liner placement. Again, this does not include leachate storage tanks, external piping, etc.

Some local factors that may affect unit prices in Table 2 include: haul distances for off-site materials; local economic conditions; contractor experience; time of year, both for bidding and construction, relating to construction calendars and season; and other factors such as clarity of plans, specs, contracts, etc.

Construction costs typically represent 15% to 25% of total site development costs. These costs include initial site preparation and subsequent site construction not performed as part of operations.

Operating costs

Operating costs represent the greatest cost for site development. They include manpower, equipment, maintenance, utilities, administration costs, and fuel.

In a state of the art Subtitle D landfill, however, items such as leachate collection, transport and treatment, leachate collection system maintenance, environmental monitoring (gas, leachate, air, and water), and gas management and control must be added.

Table 3 details typical operating costs. A review of the table points out that the state of the art landfill can add significant costs to operations for leachate handling. A site generating 10,000 gallons of leachate per day at one cent to six cents per gallon, can add as much as $219,000 in handling charges per year to operational costs. And these costs assume sewering of leachate will continue as an acceptable means of treatment. However, certain states and municipalities may require pre-treatment, which could easily add 10 cents per gallon to costs, depending on the level of treatment needed.

One further item; the cost of hauling leachate by transport versus direct sewer discharge is significant. As a result of this cost difference, many site developers consider siting facilities closer to existing sewer lines.

Table 3 Site Operations

Item	Range of Unit Prices
Operation costs for a 600-750 tpd site, including men, machines, facilities, & maintenance	$600,000-$750,000 per year
Leachate collection & treatment	
By truck: 10 mile haul	$0.02-$0.03 per gallon $65,700-$219,000 per year
By sewer: sewer charge	$0.01-$0.03 per gallon $21,900-$65,700 per year
Environmental monitoring	$8,000-$40,000 per year
Gas management and control operations	$10,000-$30,000 per year
On-going engineering, staff time, etc.	$0.00-$20,000 per year

Assume: a 40-acre site with an efficient liner and collection system with good drainage, a typical generation rate of 6,000-10,000 gpd during operations and 10,000 after closure.

Table 4 Typical Closure Costs

Item	Range of Unit Prices
Final cover	$2.50 - $5.00 per cubic yard
Topsoil	$1.20 - $2.50 per cubic yard
Seed, fertilizer & mulch	$1,000 to $1,500 ~~[illegible]~~ per acre
Gas control (passive trench*)	$4.00 - $6.00 per linear foot

* Assumption: the blower assemblies and network will be in place and that these costs were part of site construction.

Source: Creative Resource Ventures, Ltd.

Table 5 Typical Post-closure Costs

Item	Range of Unit Prices
Annual inspections	$1,000 - $8,000 per year
Land surface care	$500 - $1,000 per year
Leachate hauling & treatment (10,000 gallons/day, sewer discharge costs of $0.01 per gallon):	$36,000 per year
Environmental monitoring	$8,000 - $40,000 per quarter
Gas:	$10 per point
Groundwater:	$250 - $500 per sample location
Leachate:	$500 - $2,000 per sample
Gas Control	$10,000 - $30,000 per year

Source: Creative Resource Ventures, Ltd.

Table 6 Example of State Surcharges

State	Item/Fee	Status/Amount
Pennsylvania	Resource Recovery Fee	proposed/$1.50 per ton
Wisconsin	Environmental	in force/$0.15 per ton
	Repair Fund	proposed/$1.00 per ton
	Groundwater Fund	in force/$0.10 per ton
	Waste Management Fund	in force/$.015-.035 per ton proposed/$1.00 per ton
	Resource Recovery Fee	proposed/$2.00 per ton
Illinois	Recycling Grant Fee	in force/$0.95 per ton
New Jersey	Sanitary Landfill Facility	in force/$0.50-$1.05 per ton
Colorado	Hazardous Waste Fees	proposed/$0.15 per ton
Ohio	County Plan Fund	proposed/$0.40-$0.80 per ton

Table 7 Generic Landfill Development Cost Estimate

Item	Total Cost	Cost/Ton % of Total
Predevelopment		
Land costs	$1,000,000	$0.35/1.81
Engineering costs	$1,490,000	$0.52/2.71
Licensing costs	$42,000	$0.01/0.08
Miscellaneous development costs	$253,000	$0.09/0.46
Subtotal	$2,785,000	$0.97/5.06
Site Preparation and Construction Costs		
Phase I	$2,725,000	$0.95/4.94
Phase II	$2,001,000	$0.70/3.64
Phase III	$2,001,000	$0.70/3.64
Phase IV	$2,001,000	$0.70/3.64
Subtotal	$8,728,000	$3.05/15.86
Site Operating Costs		
Site operation	$16,620,000	$5.81/30.20
Leachate hauling & treatment	$ 2,520,000	$0.88/4.58
Environmental monitoring		
On-going engr. asst., admin., and other misc.	$ 1,640,000	$0.57/2.98
Interest on capital debt	$ 4,000,000	$1.40/7.26
Subtotal	$24,780,000	$7.27/45.02
Site Closure		
Phase I	$ 762,000	$0.27/1.38
Phase II	$ 625,000	$0.22/1.13
Phase III	$ 544,000	$0.19/0.99
Phase IV	$ 544,000	$0.19/0.99
Subtotal	$ 2,475,000	$0.87/4.49
Post-Closure care costs		
Environmental monitoring	$ 1,500,000	$0.52/2.73
Leachate hauling & treatment	$ 6,480,000	$2.27/11.77
Land surface care, site inspection, admin., and other misc. costs	$ 1,140,000	$0.40/2.07
Subtotal	$ 9,120,000	$3.19/16.57
Other		
Fees	$ 2,860,000	$1.00/5.20
Incentives	$ 4,290,000	$1.50/7.80
Subtotal	$ 7,150,000	$2.50/13.00
PROJECT TOTAL	$55,038,000	$19.25/100.00

Table 3 shows that the costs for hauling leachate on a 20-mile round trip can add as much as three cents per gallon to costs.

Environmental monitoring is an additional operational cost, which may include groundwater monitoring, leachate monitoring, gas and air monitoring, and surface water monitoring. Environmental monitoring costs are highly variable. At a given site, the figure is directly related to the number of monitoring points, the frequency of monitoring, and the number of parameters. A rule of thumb for groundwater monitoring costs is $250 to $500 per well per sampling. That may not sound like much, but consider that a well is monitored quarterly for 15 years of operation. At the upper-range, the cost for one well would be $30,000 during the site's life.

With Subtitle D requiring gas management at all new and expanding sites, costs will increase further. Gas migration control with an active gas system will add $10,000 to $30,000 per year to site operations costs. Site operations costs typically account for 40% to 50% of development costs; therefore operational costs can have the greatest impact on reducing overall development costs.

Closure costs

Site closure is the lowest overall cost associated with site development. In fact, depending on site characteristics such as available cover soils, and the amount of available equipment, a major portion of this cost will be incurred as an operational cost.

At many sites today, final capping is performed by landfill personnel as the site reaches final grade, as opposed to contracting for these services. Where this work is contracted, unit prices as shown in Table 4 can be affected by the same factors affecting site construction costs. Table 4 presents costs for typical closure work.

Depending on how much of this work was performed during operations, site closure will range from 3% to 5% of site development costs.

Post-closure care

With the publication of Subtitle D, EPA clearly intends to require extensive post-

closure care for 30 years, and leaves it to the states to require additional post-closure care if they desire.

State regulations used to drive this category. In some states, site owners are relieved of the responsibility for long-term site care 20 to 30 years after site closure. Now, post-closure periods will be 30 years or more.

Table 5 presents post-closure care cost estimates. These costs can represent 10% to 20% of site development costs, and possibly more.

Subtitle D requires site owners to provide financial assurance for long-term care during site operation. Significant portions of these monies are required up front when opening the site. This can impact future planning significantly.

Unanticipated Costs

Unanticipated costs are cost items not directly related to the cost of burying wastes, but more or less a part of landfill development now and in years to come. First, for instance, in most states, there are or will be assessments for funding recycling, groundwater, protection projects, environmental repair of old sites, or new state programs. These state assessments are normally mandated by the law that allows the state to collect a certain fee per ton or yard of waste accepted at the landfill gate. Some examples of state assessments are shown in Table 6. A recent court victory was won by waste industry interests in Illinois against an assessment whose proceeds went to a state fund that would have subsidized recycling projects.

Local incentives are a second surprise cost category. These costs help upgrade local roads, protect or guarantee property values, replace local private wells, and provide better screening. They usually are negotiated with local host municipalities under legal requirements or provided as trade-offs to get permits.

Local incentive costs can include free or cut-rate disposal for the host municipality, or money to off-set disposal costs for the local municipalities, a straight payment to the local municipalities on a per-ton or per-yard basis. This cost can range up to $1.50 per ton or more, depending on local negotiations, politics, etc.

These two surprises can add significantly to the bottom-line costs of landfilling. They could increase costs to landfill by 5% to 15%.

State of the art landfill costs: an example

To illustrate today's costs of landfill development, this section estimates the costs of developing a site located in an upper-Midwestern state in 1988 that will meet Subtitle D requirements. Costs presented in Table 7 are estimates based on Phase I construction, and are presented in 1988 dollars. Operations costs represent first-year costs.

Table 8 Landfill Development Costs Past, Present, and Future

Typical 1975 Landfill Development Cost Item	$/ton	%
Predevelopment costs	$0.25	5.9%
Construction costs	$0.52	12.3%
Operations costs	$3.20	75.7%
Closure costs	$0.26	6.1%
Post-closure care costs	$0.00	0.0%
Unanticipated costs	$0.00	0.0%
Subtotal	$4.23	100%
Profit (10-25)	$0.42-$0.85	—
Total (including profit)	$4.65-$5.08	—

Typical 1988 Landfill Development Cost Item	$/ton	%
Predevelopment costs	$0.42-$1.30	3-6%
Construction costs	$2.60-$4.90	15-25%
Operations costs	$4.50-$6.50	30-40%
Closure costs	$0.50-$1.00	3-5%
Post-closure care costs	$2.00-$4.00	10-20%
Unanticipated costs	$1.00-$2.50	5-15%
Subtotal	$11.02-$22.20	100%
Profit (10-25)	$1.00-$5.50	—
Total (including profit)	$12.02-$27.70	—

Typical 1990 Landfill Development Cost Item	$/ton	%
Predevelopment costs	$1.50	7.3%
Construction costs	$5.00	24.4%
Operations costs	$8.00	39.0%
Closure costs	$1.00	4.8%
Post-closure care costs	$3.00	14.7%
Unanticipated costs	$2.00	9.8%
Subtotal	$20.50	100%
Profit (10-25)	$2.05-$5.12	—
Total (including profit)	$22.55-$25.62	—

Predevelopment costs will include: 1,000 ton per day municipal solid waste facility; 4:1 cover to waste ratio; 10-year site life; 5.5-day work-week; 60-foot average depth of fill; buffer area for screening and on-site borrow; phased development in four equal phases (18.5 acres each); phases are closed as new phases are developed; estimated site selection and initial feasibility report costs; estimated licensing and regulatory review fees; and administration, contingency, and miscellaneous cost factors.

Site preparation costs will include: 3-foot clay liner using on-site materials; 1-foot sand blanket using off-site materials; 6-inch PVC collection pipe in the

Table 9 Cost Components/Breakdowns for Various Items

G[illegible]dwater Monitoring:

	10 wells	30 wells
installation	$15,000	— $300,000
monitoring	$600,000	— $2,600,000
Total	$615,000	— $2,900,000

Gas Control/Monitoring:
$500 per internal wall vent (every 200 feet)
$500 to $1,500 per monitoring point installed
$10 to $100 per sample per point

	low case	high case
installation	$17,500	— $28,000
monitoring	$14,000	— $45,000
gas control	$50,000	— $500,000

Total $81,500 - $573,500
Assume: internal wall vent every 200 feet; $10.00-$100.00 per sample point; $10,000-$30,000 for operation and maintenance.

Liner & leachate Collection Costs

Clay	$2.40-$4.00 per cubic yard
Sand	$8.00-$12.00 per cubic yard
Synthetic (flexible membrane) liner	$0.80-$1.20 per sq. ft. installed
Lysimeters	
5[illegible] 100:	$5,000-$7,000
[illegible]" PVC)	$15.00-$20.00 per linear foot
L[illegible]ation	$20,000-$40,000
Manhole	$1,500-$8,000
10,000 gal. tank	$20,000-$40,000 each (double wall)
Total	

40-acre site, 5-foot clay liner, 2 lysimeters. $40,000 to $60,000 per acre	$2,200,000
40-acre site, synthetic liner. $60,000 to $100,000 per acre	$3,500,000

Leachate Transport & Treatment

10-mile haul	$0.02-$0.03 per gallon
Treatment	$0.01-$0.03 per gallon
10,000 gallons per day	$65,700 to $219,000 per year
Over 40 years	$2,628,500-$8,760,000 over site life

Assume: 40-acre site, humid environment & efficient collection.

Run-on/Run-off (Surface Water) Controls

Ditching	$0.05- $1.70 per linear foot
Sedimentation basin	$1,000-$20,000 per unit
Monitoring	$100 to $500 per point
Total	
Construction	$36,000
Monitoring	$40,000
	$64,000

Assume: 40-acre site, two basins, perimeter ditch, quarterly monitoring over 45 years.

Closure Costs

Final cover	$2.50-$5.00 per cubic yard
Gas system	(already covered)
Topsoil	$1.20-2.50 per cubic yard
Seed, etc.	$1,000-$2,000 per acre
Leachate wells	$5,000-$10,000 each
Documentation	$10,000-$20,000
Total	$500,000

Assume: 40-acre site, two feet of final cover clay, two wells, four phases.

Post closure care costs

Annual inspections	$1,000-$9,000 per year
Land surface care	$500-$1,000 per year
Leachate transport & treatment	$65,700-$219,000 per year
Monitoring	$8,000-$40,000 per year
Leachate system maintenance	$1,000 to $3,000 per year
Total Per year	$76,000-$272,000
Over 30 years	$2,280,000-$8,160,000

Assume: 40-acre site, leachate collection, 2.5 feet of final cover, 30 years of long-term care.

leachate collection system; collection pipe placed at 200 feet on center; 10-foot excavation assumed; active gas collection and flaring system; bituminous entrance road and gravel on-site roads; and estimated surface drainage system.

Site operating costs will include: adequate material available on-site for daily cover; and off-site treatment of leachate.

S[illegible] closure costs will include: 3-foot clay cap; 3-fo[illegible] tective cover and topsoil layer; and adequate ava[illegible]e material on-site for the cap and protective cover layer.

Post-closure care costs will include: 30-year post-closure care period; and maintenance of environmental monitoring systems and leachate collection system.

As seen in Table 7, construction costs for Phases Two, Three, and Four are substantially less than for Phase One. The first phase includes initial access road and building construction, and reflects the costs of excavating large quantities of soil to reach base grades. Operational costs reflect significant dollars for base operations but also for leachate, monitoring, and interest on debt to develop and construct the site.

Note how significant a portion of total costs the post-

c... ..e costs and other fees are becoming. When you start to pay local incentives on a per ton basis or state fees, and you have to care for a site for 30 years after closure, costs will increase remarkably.

A look at the future

In the past, the distribution of costs for the six major areas of landfill development was substantially different from present landfill development practices. Table 8 shows how site development costs have changed over time and may change in the future: Table 9 breaks down cost components, and offers an interesting look at some key costs.

The majority of facility costs (nearly 80%) were previously for site operations. This left only 20% for the other five areas. In the past, no money was allotted for long-term care or unanticipated costs. Note, too, that all costs presented do not yet include profit or site replacement costs (i.e., the cost of acquiring and developing the site that will be needed once the current landfill is closed). For private developers, profit must be based on a fair return on investment and compensation for the money at risk. In setting a fair profit, an owner must also consider competition. In the public sector, landfill replacement costs may be considered in lieu of profit.

In general, profit or replacement costs may add 10% to 20% or even more to site development costs, depending on the specific conditions of each location.

For today's landfill, excluding profit, site operations still represent almost half of costs (40% to 50%). However, site construction of a state of the art landfill is costly (15% to 25% of overall costs), because of new design and operating requirements. Long-term care costs also are significant. Landfill development costs now include money for post-closure care, compared to 0% in the past. And surprise costs are real.

In the future, which Table 8 projects, it is likely costs will not rise dramatically over 1988 costs. Costs will likely stabilize as we become more experienced with sophisticated construction. In some states, costs already reflect Subtitle D regulations. The costs for landfilling are beginning to or will level out around $20.00 to $25.00 per ton. The price for disposal on the other hand will vary with market conditions. ■